NOAA TECHNICAL MEMORANDUM NWS ER 79

# An Examination of NGM Low Level Temperature

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November 1988

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## ABSTRACT

Nested Grid Model (NGM) low level temperatures, initial and forecast, are available to forecasters in a FOUS message for selected locations. A study is presented that examines the NGM low level temperature forecasts for any bias, amount of bias, and any changes in bias since NGM low level temperatures became available.

## INTRODUCTION

The NGM has been producing operational 0-48 hour numerical forecasts for the North American continent twice daily since late March 1985. NGM FOUS messages became available in October 1985.

From the time of its beginning operational forecasts, objective and subjective evaluations of the NGM demonstrated that the modeling system produced reliable forecasts. However, systematic errors in forecast temperatures, caused by the omission of certain physical processes in the model, were identified.

In July 1986 a more complete formulation of physical processes were introduced into the NGM. Longwave and shortwave radiation, including a diurnal cycle, surface fluxes of heat and moisture over land, and a new turbulent mixing process were added to the model. Important modifications were also made to the representation of cumulus convection by the model.

Implementation of the new physics was to improve the NGM's forecasts of sensible weather such as precipitation, low level temperatures, surface induced circulations such as land/sea breezes, the diurnal variation of low level winds, and maximum and minimum temperatures.

The radiational heating calculations that were introduced in the NGM in July 1986 were credited with producing a progressively colder temperature field, at the rate of about -1.5 degrees Celsius in 48 hours, at almost all levels. The cold error continued for more than a year.

In 1987 two modifications, one minor and one major, were introduced into the NGM to reduce errors in the forecast temperatures:

1. In August a change to the near-surface air temperatures used to calculate radiation.

2. In October at each level, the hemispherically-averaged potential temperature was kept constant during the forecast, at its initial value.

The result of these two changes was to reduce the cold bias of NGM forecast temperatures and a small reduction in the areas of forecast precipitation.

This study examines the NGM low level temperature forecasts for any bias and looks at how additions and modifications to the model may have changed any bias found. The author in collecting and studying the NGM low level temperature forecasts had several questions to answer:

1. Is there any temperature bias? If so, how much?

2. Does any bias change from one forecast cycle to another?

3. Does any bias show any diurnal variation?

4. Does any bias when precipitation is forecast differ from any bias when no precipitation is forecast? Does forecast cycle or valid time make any difference?

5. Does any bias when precipitation is observed differ from any bias when no precipitation is observed? Does forecast cycle or valid time make any difference?

## PROCEDURE

Low level temperature forecasts from NGM FOUS messages were compared with initial low level temperatures, valid at the same time, from NGM FOUS messages. algebraic differences and absolute value differences were totaled and averaged at 12 hour intervals (times corresponding to 00Z and 12Z) for 12, 24, 36, and 48 hours from initial data time.

Data for both forecast cycles (00Z and 12Z) were initially combined for all three winter seasons. This was done in order to see if there were any overall biases, trends, or changes that occurred in a season or from season to season. Next the data was stratified by forecast cycle time or initial data time and then by forecast valid time. This would make it easier to see if there was any difference in the temperatures forecast from one forecast cycle time to the other. It would also make it easy to see if the model had any diurnal variability by comparing the forecast temperatures at one valid time to those at the other valid time.

The data from both forecast cycles were then combined and stratified by whether precipitation was forecast to occur or not. This was determined for each location from the NGM FOUS message. If a precipitation amount greater than zero was shown in the NGM FOUS message for one of the 12 hour interval times (00Z or 12Z), it was considered a forecast of precipitation by the model at that time. If no precipitation was shown in the NGM FOUS message, it was defined as a forecast of no precipitation. This data was then stratified by forecast cycle time and by forecast valid time.

The data from both forecast cycles times were combined one more time and stratified by whether precipitation was observed or not. This was determined for each location by observations from that location. It had nothing to do with the intensity of the precipitation or whether it was even measurable. The simple fact that precipitation was occurring at the valid time of the forecast temperature was counted as a precipitation event. Obviously, an observation of no precipitation at the valid time of the forecast temperature counted as a no precipitation event. The data was further stratified by forecast cycle time and by forecast valid time.

Combined data for four stations located in Maine and New Hampshire were used to preserve geographic homogeniety and at the same time yield sufficient cases from which to arrive at conclusions. The four stations chosen were Concord, New Hampshire; and Portland, Bangor, and Caribou, Maine.

Data for the winter season (October through March) for the winters of 1985-86, 1986-87, and 1987-88 were used in this study. The data for the 1987-88 season excluded any data in October before the NGM changed to holding constant the hemispherically-averaged potential temperature.

RESULTS

Table 1. shows the average algebraic temperature error and average absolute temperature error of the NGM low level temperatures T1, T3, and T5 for the last three winter seasons. Both forecast cycles (00Z and 12Z) are combined in Table 1. Note that the algebraic sum of all three temperatures is negative for all three winters at all four 12 hour intervals after initial data time. The winter of 1986-87 is considerably colder (more negative) than the other two winter seasons. It is consistently the coldest at all three temperature levels and also gets progressively colder with time. This is not the case with the winters of 1985-86 and 1987-88. Those two winters actually had the least algebraic error sum 48 hours after initial data time. In fact, the algebraic error sums at each 12 hour interval are very similar for the winters of 1985-86 and 1987-88.

The coldest algebraic temperature errors are at NGM temperature T1 for all three winters. The warmest algebraic temperature errors are at NGM temperature T5 for all three winters. In fact, the algebraic error is positive at each 12 hour interval for the 1985-86 winter and is positive at 24, 36, and 48 hours and only slightly negative at 12 hours for the 1987-88 winter. The average algebraic error for T5 gets progressively warmer with time during the winters of 1985-86 and 1987-88. The opposite was true in the 1986-87 winter season.

The sum of the average absolute temperature errors are similar for the 1985-86 and 1986-87 winter seasons. The sum of the average absolute temperatures for the 1987-88 winter season was consistently less than in the two previous winters. The difference in the sum of average absolute temperature errors between the 1987-88 season and that for the two previous winter seasons was about one degree at time 12 hours and increased to about 2.5 degrees at time 48 hours.

Table 2. shows the same data as in Table 1., but stratified by forecast cycle time or initial data time (00Z or 12Z). Table 3. shows

the same data, but stratified by forecast valid time (00Z or 12Z). It is difficult to say that one forecast cycle is warmer or colder than the other when looking at the data in Table 2. But, there does appear to be evidence of diurnal variability in the forecast temperatures errors shown in Table 3. This is particularly true for the winter of 1985-86. The algebraic temperature errors from forecast temperatures valid at 00Z during that winter season were substantially larger and colder than those valid at 12Z. The data for the winter of 1986-87, with the exception data 24 hours after initial data time, is also colder at 00Z. But, the degree of error is not substantially larger from one valid time to the other. During the 1987-88 winter season only the forecast temperatures valid 12 hours after initial data time were colder at 00Z than at 12Z. As previously noted, the algebraic errors in 1986-87 are markedly colder for both forecast cycles and at both valid times than those for the other two winter seasons.

Algebraic temperature errors for temperature T1 are colder at valid time 12Z during the winters of 1986-87 and 1987-88. The opposite is true for the 1985-86 winter season. The algebraic temperature errors for temperature T3 are colder at valid time 00Z for all three winter seasons. Algebraic temperature errors for temperature T5 were for the most part positive (too warm) during the winters of 1985-86 and 1987-88 and slightly negative (too cold) during 1986-87. The warmest algebraic errors generally occurred at the 12Z valid time during 1985-86 and 1986-87. With the exception of the 12 hour forecasts in 1987-88, the opposite was true.

The sum of the absolute temperature errors is noticeably greater at the 00Z valid time in 1985-86. For the most part the sum of the absolute temperature errors from one valid time to another is closer to each other and tend toward the 12Z valid time being larger in the other two winter seasons. The pattern of average absolute temperature errors for temperatures T1, T3, and T5 are similar to the average algebraic errors over the three winters.

Table 4. shows the average algebraic forecast temperature errors and Table 5. shows the average absolute forecast temperature errors for all three winters when separated into forecasts of precipitation and forecasts of no precipitation. Data for both forecast cycles are combined in both tables.

The sum of the average algebraic errors is considerably colder when no precipitation is forecast than when precipitation is forecast to occur. The sum of the average absolute errors is also larger when there is a forecast of no precipitation. The same can be said for all three NGM temperature forecasts for all three winters. It is interesting to note that the large negative algebraic errors at T1 and T3 have mostly disappeared when precipitation is forecast by the model. In fact, during 1987-88 the average algebraic error for T1 was generally positive when precipitation was forecast.

Table 6. shows the average algebraic forecast temperature errors when the data were stratified by forecast cycle time and by NGM forecast of precipitation or no precipitation. Table 7. shows the average

absolute forecast temperature errors when the data was stratified in the same manner. Table 8. shows the average algebraic forecast temperature errors when the data were stratified by forecast valid time and NGM forecast of precipitation or no precipitation. Table 9. shows the average absolute errors of forecast temperatures when the data were separated in the same manner as in Table 8.

The data for the winter of 1985-86 suggest a forecast cycle bias. The sum of the average algebraic errors are colder for the 12Z forecast cycle when precipitation is forecast to occur than at the 00z forecast cycle. This is true 12 and 24 hours after initial data time in 1986-87, but falls apart at 36 and 48 hours. For 1987-88 a bias toward forecast valid time is evident. The sum of the algebraic errors is colder at the 12Z valid time than at the 00Z valid time when precipitation is forecast to occur.

A review of the average absolute errors does not suggest a forecast cycle bias for the winter of 1985-86. Instead, it points more toward a forecast valid time bias. The sum of the average absolute errors is greater at the 00Z valid time than at the 12Z valid time whether precipitation is forecast to occur or not. When precipitation was forecast to occur in the winter of 1986-87, the 12Z valid time had the larger absolute error sum. These two items could lead one to believe that a forecast diurnal cycle bias for forecast precipitation events existed in those two winters. However, the winter of 1987-88 hinted at more of a forecast cycle bias during forecast precipitation events. With the exception of the 48 hour forecast, the 12Z forecast cycle had greater absolute error sums than the 00Z forecast cycle.

Table 10. shows the average algebraic errors for all NGM temperature forecasts when separated into cases of observed precipitation and of no observed precipitation. Table 11. shows the average absolute errors for the same data using the same method of stratification. The pattern of errors, both algebraic and absolute, is similar to that shown when the data were stratified by whether precipitation was forecast or not. However, the cases of observed precipitation are somewhat colder and the cases of no observed precipitation are somewhat warmer than the events in Table 4. The absolute errors are similar to those found when stratifying by forecasts of precipitation or no precipitation.

Table 12. shows the average algebraic errors when the data is stratified by forecast cycle time and by the occurrence or non-occurrence of precipitation. Table 13. shows the average absolute errors for the same data. Tables 14. and 15. show the same data as in Tables 12. and 13., only they are stratified by forecast valid time not forecast cycle time.

The sum of the algebraic errors shows a cold bias by forecast valid time during the winters of 1986-87 and 1987-88. When precipitation is observed, the temperature forecasts valid at 12Z are colder than those valid at 00Z. This was the case in 1987-88 when precipitation was forecast by the NGM. The average absolute error sums point toward a forecast valid time bias when precipitation is observed. During 1986-86 the forecasts valid at 00Z had the larger absolute errors and in 1987-88 the forecasts valid at 12Z had the larger absolute errors.

## CONCLUSIONS

This study has shown that a cold bias in NGM forecast temperatures T1 and T3 existed from the beginning of the model providing FOUS message output. The changes made to the model in July 1986 not only produced a progressively colder bias as forecast time increased from initial data time, but has been shown in this study to make the cold bias even colder at all forecast times. Based on the data presented in this study, the additions and corrections introduced to the model in 1987 lessened the cold bias. But, they only brought the bias back to the levels that were observed in the beginning (1985-86). A cold bias still exists in the NGM T1 and T3 temperature forecasts. Any bias of NGM T5 temperature forecasts is much warmer and tends to be positive. The changes made to the NGM did decrease the average absolute error for NGM temperature forecasts.

There doesn't appear to be any strong evidence of a temperature bias dependent upon forecast cycle time. There is evidence of a bias dependent upon forecast valid time. NGM T1 temperature forecasts are colder at forecast valid time 12Z. NGM T3 temperature forecasts are colder at forecast valid time 00Z.

There is a marked difference in average algebraic errors for NGM temperature forecasts when precipitation is forecast by the model. The sum of the average algebraic errors is generally positive when precipitation is forecast by the model, and for the most part the large cold bias of T1 and T3 all but disappear when precipitation is forecast by the NGM. Much the same is true, but to a lesser degree, when precipitation is observed. Whether no precipitation is forecast or no precipitation is observed, the NGM temperature forecasts T1 and T3 have a cold bias.

This study has presented a detailed examination of NGM low level temperature forecasts for one geographical area. Whether the results presented apply to other areas of the country can only be determined through an examination of data for those areas. The marked difference in temperature bias when precipitation is forecast from that when no precipitation is forecast needs to be pursued further. If this bias is widespread, corrections could be made to the model that could greatly improve its output.

WINTER 1985 - 1986

| | 12 HR (958) | 24 HR (937) | 36 HR (915) | 48 HR (927) |
|---|---|---|---|---|
| T1 | -1.47 | -2.63 | -3.13 | -3.36 |
| T3 | -1.04 | -0.77 | -0.69 | -0.18 |
| T5 | +0.34 | +1.01 | +1.32 | +1.86 |
| SUM | -2.17 | -2.38 | -2.50 | -1.68 |
| | | | | |
| T1 | 2.91 | 3.72 | 4.40 | 4.77 |
| T3 | 1.94 | 1.92 | 2.30 | 2.56 |
| T5 | 0.99 | 1.40 | 1.86 | 2.53 |
| SUM | 5.83 | 7.04 | 8.56 | 9.85 |

WINTER 1986 - 1987

| | 12 HR (1252) | 24 HR (1245) | 36 HR (1239) | 48 HR (1212) |
|---|---|---|---|---|
| T1 | -2.02 | -2.78 | -3.46 | -3.82 |
| T3 | -1.77 | -2.55 | -2.82 | -2.85 |
| T5 | -0.53 | -0.64 | -0.74 | -0.76 |
| SUM | -4.31 | -5.96 | -7.02 | -7.43 |
| | | | | |
| T1 | 2.38 | 3.04 | 3.64 | 4.14 |
| T3 | 2.18 | 2.79 | 3.18 | 3.45 |
| T5 | 1.07 | 1.23 | 1.49 | 1.93 |
| SUM | 5.64 | 7.06 | 8.32 | 9.53 |

WINTER 1987 - 1988

| | 12 HR (1171) | 24 HR (1178) | 36 HR (1167) | 48 HR (1180) |
|---|---|---|---|---|
| T1 | -1.37 | -1.55 | -1.56 | -1.29 |
| T3 | -0.72 | -0.90 | -0.95 | -0.70 |
| T5 | -0.08 | +0.09 | +0.25 | +0.61 |
| SUM | -2.17 | -2.35 | -2.26 | -1.39 |
| | | | | |
| T1 | 1.98 | 2.15 | 2.38 | 2.51 |
| T3 | 1.63 | 1.86 | 2.15 | 2.50 |
| T5 | 1.01 | 1.14 | 1.45 | 2.11 |
| SUM | 4.62 | 5.15 | 5.98 | 7.13 |

TABLE 1. Average algebraic temperature error and average absolute temperature error for the winter season (October through March) for the winters 1985-86, 1986-87, 1987-88. Numerals in parentheses are number of cases for specific time periods after initial data time.

WINTER 1985 - 1986

| | 12 HR(490/468) | | 24 HR(502/435) | | 36 HR(458/457) | | 48 HR(507/420) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -0.05 | -2.95 | -3.03 | -2.17 | -1.73 | -4.54 | -3.90 | -2.71 |
| T3 | -0.20 | -1.93 | -0.83 | -0.69 | -0.10 | -1.29 | -0.49 | +0.19 |
| T5 | +0.55 | +0.12 | +1.02 | +1.00 | +1.35 | +1.30 | +1.72 | +2.02 |
| SUM | +0.30 | -4.76 | -2.84 | -1.85 | -0.48 | -4.53 | -2.66 | -0.50 |
| | | | | | | | | |
| T1 | 2.11 | 3.74 | 3.99 | 3.41 | 3.27 | 5.53 | 5.11 | 4.36 |
| T3 | 1.44 | 2.46 | 2.00 | 1.82 | 2.04 | 2.57 | 2.60 | 2.50 |
| T5 | 1.08 | 0.89 | 1.38 | 1.43 | 1.87 | 1.84 | 2.38 | 2.71 |
| SUM | 4.63 | 7.09 | 7.37 | 6.65 | 7.18 | 9.94 | 10.09 | 9.57 |

WINTER 1986 - 1987

| | 12 HR(627/625) | | 24 HR(653/592) | | 36 HR(624/615) | | 48 HR(632/580) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -2.85 | -1.19 | -2.08 | -3.54 | -3.84 | -3.07 | -3.13 | -4.57 |
| T3 | -0.88 | -2.66 | -2.92 | -2.14 | -2.12 | -3.53 | -3.53 | -2.12 |
| T5 | -0.41 | -0.65 | -0.63 | -0.66 | -0.69 | -0.80 | -0.87 | -0.64 |
| SUM | -4.13 | -4.50 | -5.63 | -6.33 | -6.65 | -7.39 | -7.53 | -7.33 |
| | | | | | | | | |
| T1 | 3.09 | 1.67 | 2.42 | 3.72 | 4.05 | 3.23 | 3.46 | 4.89 |
| T3 | 1.53 | 2.83 | 3.12 | 2.43 | 2.58 | 3.80 | 3.88 | 2.98 |
| T5 | 1.02 | 1.13 | 1.26 | 1.20 | 1.43 | 1.55 | 1.92 | 1.95 |
| SUM | 5.64 | 5.63 | 6.79 | 7.44 | 8.06 | 8.57 | 9.26 | 9.82 |

WINTER 1987 - 1988

| | 12 HR(587/584) | | 24 HR(611/567) | | 36 HR(584/583) | | 48 HR(610/570) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -1.81 | -0.93 | -1.26 | -1.86 | -2.02 | -1.10 | -0.97 | -1.65 |
| T3 | -0.15 | -1.29 | -1.17 | -0.60 | -0.83 | -1.08 | -1.02 | -0.36 |
| T5 | +0.06 | -0.21 | +0.14 | +0.05 | +0.14 | +0.35 | +0.77 | +0.42 |
| SUM | -1.90 | -2.43 | -2.29 | -2.41 | -2.71 | -1.82 | -1.21 | -1.59 |
| | | | | | | | | |
| T1 | 2.29 | 1.67 | 1.77 | 2.56 | 2.73 | 2.02 | 2.36 | 2.68 |
| T3 | 1.37 | 1.88 | 1.92 | 1.80 | 2.08 | 2.22 | 2.36 | 2.39 |
| T5 | 0.94 | 1.09 | 1.14 | 1.14 | 1.47 | 1.43 | 2.12 | 2.10 |
| SUM | 4.61 | 4.63 | 4.83 | 5.50 | 6.28 | 5.68 | 7.08 | 7.17 |

TABLE 2. Average algebraic temperature error and average absolute temperature error for the winter season (October through March) for the winters 1985-86, 1986-87, 1987-88 stratified by forecast cycle time (0000Z or 1200Z). Numerals in parentheses are number of cases by cycle time (00Z/12Z) for specific time periods after initial data time.

WINTER 1985 - 1986

| | 12 HR(468/490) | | 24 HR(502/435) | | 36 HR(457/458) | | 48 HR(507/420) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -2.95 | -0.05 | -3.03 | -2.17 | -4.54 | -1.73 | -3.90 | -2.71 |
| T3 | -1.93 | -0.20 | -0.83 | -0.69 | -1.29 | -0.10 | -0.49 | +0.19 |
| T5 | +0.12 | +0.55 | +1.02 | +1.00 | +1.30 | +1.35 | +1.72 | +2.02 |
| SUM | -4.76 | +0.30 | -2.84 | -1.85 | -4.53 | -0.48 | -2.66 | -0.50 |
| | | | | | | | | |
| T1 | 3.74 | 2.11 | 3.99 | 3.41 | 5.53 | 3.27 | 5.11 | 4.36 |
| T3 | 2.46 | 1.44 | 2.00 | 1.82 | 2.57 | 2.04 | 2.60 | 2.50 |
| T5 | 0.89 | 1.08 | 1.38 | 1.43 | 1.84 | 1.87 | 2.38 | 2.71 |
| SUM | 7.09 | 4.63 | 7.37 | 6.65 | 9.94 | 7.18 | 10.09 | 9.57 |

WINTER 1986 - 1987

| | 12 HR(625/627) | | 24 HR(653/592) | | 36 HR(615/624) | | 48 HR(632/580) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -1.19 | -2.85 | -2.08 | -3.54 | -3.07 | -3.84 | -3.13 | -4.57 |
| T3 | -2.66 | -0.88 | -2.92 | -2.14 | -3.53 | -2.12 | -3.53 | -2.12 |
| T5 | -0.65 | -0.41 | -0.63 | -0.66 | -0.80 | -0.69 | -0.87 | -0.64 |
| SUM | -4.50 | -4.13 | -5.63 | -6.33 | -7.39 | -6.65 | -7.53 | -7.33 |
| | | | | | | | | |
| T1 | 1.67 | 3.09 | 2.42 | 3.72 | 3.23 | 4.05 | 3.46 | 4.89 |
| T3 | 2.83 | 1.53 | 3.12 | 2.43 | 3.80 | 2.58 | 3.88 | 2.98 |
| T5 | 1.13 | 1.01 | 1.26 | 1.20 | 1.55 | 1.43 | 1.92 | 1.95 |
| SUM | 5.63 | 5.64 | 6.79 | 7.44 | 8.57 | 8.06 | 9.26 | 9.82 |

WINTER 1987 - 1988

| | 12 HR(584/587) | | 24 HR(611/567) | | 36 HR(583/584) | | 48 HR(610/570) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -0.93 | -1.81 | -1.26 | -1.86 | -1.10 | -2.02 | -0.97 | -1.65 |
| T3 | -1.29 | -0.15 | -1.17 | -0.60 | -1.08 | -0.83 | -1.02 | -0.36 |
| T5 | -0.21 | +0.06 | +0.14 | +0.05 | +0.35 | +0.14 | +0.77 | +0.42 |
| SUM | -2.43 | -1.90 | -2.29 | -2.41 | -1.82 | -2.71 | -1.21 | -1.59 |
| | | | | | | | | |
| T1 | 1.67 | 2.29 | 1.77 | 2.56 | 2.02 | 2.73 | 2.36 | 2.68 |
| T3 | 1.88 | 1.37 | 1.92 | 1.80 | 2.22 | 2.08 | 2.36 | 2.39 |
| T5 | 1.09 | 0.94 | 1.14 | 1.14 | 1.43 | 1.47 | 2.12 | 2.10 |
| SUM | 4.63 | 4.61 | 4.83 | 5.50 | 5.68 | 6.28 | 7.08 | 7.17 |

TABLE 3. Average algebraic temperature error and average absolute temperature error for the winter season (October through March) for the winters 1985-86, 1986-87, 1987-88 stratified by forecast valid time (0000Z or 1200Z). Numerals in parentheses are number of cases by valid time (00Z/12Z)for specific time periods after initial data time.

WINTER 1985 - 1986

PRECIPITATION FORECAST

| | 12 HR (250) | 24 HR (258) | 36 HR (260) | 48 HR (264) |
|---|---|---|---|---|
| T1 | +0.08 | -0.62 | -0.80 | -0.55 |
| T3 | -0.33 | -0.57 | -0.38 | +0.21 |
| T5 | +0.36 | +1.05 | +1.50 | +1.94 |
| SUM | +0.10 | -0.14 | +0.33 | +1.60 |

NO PRECIPITATION FORECAST

| | 12 HR (708) | 24 HR (679) | 36 HR (655) | 48 HR (663) |
|---|---|---|---|---|
| T1 | -2.01 | -3.39 | -4.06 | -4.48 |
| T3 | -1.30 | -0.84 | -0.82 | -0.34 |
| T5 | +0.34 | +1.00 | +1.25 | +1.83 |
| SUM | -2.97 | -3.24 | -3.63 | -2.99 |

WINTER 1986 - 1987

PRECIPITATION FORECAST

| | 12 HR (206) | 24 HR (266) | 36 HR (286) | 48 HR (293) |
|---|---|---|---|---|
| T1 | -0.37 | -1.10 | -2.06 | -1.86 |
| T3 | -0.97 | -1.85 | -2.19 | -2.12 |
| T5 | -0.07 | -0.29 | -0.30 | -0.25 |
| SUM | -1.42 | -3.23 | -4.55 | -4.22 |

NO PRECIPITATION FORECAST

| | 12 HR (1046) | 24 HR (979) | 36 HR (953) | 48 HR (919) |
|---|---|---|---|---|
| T1 | -2.34 | -3.23 | -3.88 | -4.45 |
| T3 | -1.93 | -2.74 | -3.01 | -3.09 |
| T5 | -0.62 | -0.74 | -0.88 | -0.92 |
| SUM | -4.89 | -6.70 | -7.76 | -8.45 |

WINTER 1987 - 1988

PRECIPITATION FORECAST

| | 12 HR (144) | 24 HR (171) | 36 HR (164) | 48 HR (187) |
|---|---|---|---|---|
| T1 | +0.25 | -0.10 | +0.28 | +0.18 |
| T3 | -0.29 | -0.19 | +0.06 | +0.21 |
| T5 | +0.09 | +0.20 | +0.85 | +1.26 |
| SUM | +0.05 | -0.09 | +1.20 | +1.66 |

NO PRECIPITATION FORECAST

| | 12 HR (1027) | 24 HR (1007) | 36 HR (1003) | 48 HR (993) |
|---|---|---|---|---|
| T1 | -1.59 | -1.79 | -1.86 | -1.57 |
| T3 | -0.78 | -1.02 | -1.12 | -0.87 |
| T5 | -0.10 | +0.08 | +0.15 | +0.48 |
| SUM | -2.48 | -2.73 | -2.83 | -1.96 |

TABLE 4. Average algebraic temperature error for the winter season (October through March) for the winters 1985-86, 1986-87, 1987-88 stratified by NGM forecasts of precipitation or no precipitation. Numerals in parentheses are number of cases for specific time periods after initial data time.

WINTER 1985 - 1986

PRECIPITATION FORECAST

| | 12 HR (250) | 24 HR (258) | 36 HR (260) | 48 HR (264) |
|---|---|---|---|---|
| T1 | 2.71 | 3.12 | 3.66 | 3.94 |
| T3 | 1.71 | 2.05 | 2.46 | 2.93 |
| T5 | 1.01 | 1.47 | 2.08 | 2.70 |
| SUM | 5.43 | 6.64 | 8.20 | 9.58 |

NO PRECIPITATION FORECAST

| | 12 HR (708) | 24 HR (679) | 36 HR (655) | 48 HR (663) |
|---|---|---|---|---|
| T1 | 2.97 | 3.95 | 4.69 | 5.10 |
| T3 | 2.02 | 1.86 | 2.24 | 2.41 |
| T5 | 0.98 | 1.38 | 1.77 | 2.46 |
| SUM | 5.97 | 7.19 | 8.70 | 9.96 |

WINTER 1986 - 1987

PRECIPITATION FORECAST

| | 12 HR (206) | 24 HR (266) | 36 HR (286) | 48 HR (293) |
|---|---|---|---|---|
| T1 | 1.61 | 2.04 | 2.78 | 3.19 |
| T3 | 1.53 | 2.21 | 2.83 | 3.30 |
| T5 | 1.14 | 1.17 | 1.56 | 2.18 |
| SUM | 4.28 | 5.41 | 7.17 | 8.67 |

NO PRECIPITATION FORECAST

| | 12 HR (1046) | 24 HR (979) | 36 HR (953) | 48 HR (919) |
|---|---|---|---|---|
| T1 | 2.54 | 3.31 | 3.88 | 4.45 |
| T3 | 2.30 | 2.95 | 3.29 | 3.50 |
| T5 | 1.06 | 1.25 | 1.47 | 1.86 |
| SUM | 5.90 | 7.50 | 8.66 | 9.80 |

WINTER 1987 - 1988

PRECIPITATION FORECAST

| | 12 HR (144) | 24 HR (171) | 36 HR (164) | 48 HR (187) |
|---|---|---|---|---|
| T1 | 1.40 | 1.85 | 2.27 | 2.46 |
| T3 | 1.35 | 1.64 | 2.22 | 2.62 |
| T5 | 1.01 | 1.19 | 1.72 | 2.53 |
| SUM | 3.77 | 4.68 | 6.21 | 7.61 |

NO PRECIPITATION FORECAST

| | 12 HR (1027) | 24 HR (1007) | 36 HR (1003) | 48 HR (993) |
|---|---|---|---|---|
| T1 | 2.06 | 2.20 | 2.40 | 2.52 |
| T3 | 1.66 | 1.90 | 2.14 | 2.48 |
| T5 | 1.02 | 1.13 | 1.41 | 2.03 |
| SUM | 4.74 | 5.23 | 5.94 | 7.03 |

TABLE 5. Average absolute temperature error for the winter season (October through March) for the winters 1985-86, 1986-87, 1987-88 stratified by NGM forecasts of precipitation or no precipitation. Numerals in parentheses are number of cases for specific time periods after initial data time.

WINTER 1985 - 1986

PRECIPITATION FORECAST

| | 12 HR(129/121) | | 24 HR(137/121) | | 36 HR(120/140) | | 48 HR(156/108) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | +0.79 | -0.69 | -0.73 | -0.50 | +0.03 | -1.51 | -0.67 | -0.38 |
| T3 | +0.03 | -0.72 | -0.31 | -0.87 | -0.61 | -0.18 | +0.62 | -0.38 |
| T5 | +0.60 | +0.10 | +1.04 | +1.07 | +1.44 | +1.56 | +2.13 | +1.67 |
| SUM | +1.42 | -1.31 | +0.01 | -0.30 | +0.87 | -0.14 | +2.08 | +0.91 |

NO PRECIPITATION FORECAST

| | 12 HR(361/347) | | 24 HR(365/314) | | 36 HR(338/317) | | 48 HR(351/312) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -0.35 | -3.74 | -3.90 | -2.81 | -2.36 | -5.88 | -5.33 | -3.52 |
| T3 | -0.28 | -2.35 | -1.03 | -0.62 | +0.09 | -1.78 | -0.98 | +0.39 |
| T5 | +0.53 | +0.13 | +1.02 | +0.98 | +1.32 | +1.18 | +1.54 | +2.14 |
| SUM | -0.09 | -5.97 | -3.90 | -2.46 | -0.95 | -6.48 | -4.77 | -0.98 |

WINTER 1986 - 1987

PRECIPITATION FORECAST

| | 12 HR(108/98) | | 24 HR(121/145) | | 36 HR(158/128) | | 48 HR(133/160) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -0.66 | -0.06 | -0.83 | -1.32 | -2.37 | -1.66 | -1.48 | -2.18 |
| T3 | -0.79 | -1.17 | -1.64 | -2.01 | -2.25 | -2.10 | -2.41 | -1.88 |
| T5 | +0.06 | -0.21 | -0.12 | -0.42 | -0.43 | -0.15 | -0.35 | -0.16 |
| SUM | -1.39 | -1.45 | -2.60 | -3.75 | -5.06 | -3.91 | -4.23 | -4.21 |

NO PRECIPITATION FORECAST

| | 12 HR(519/527) | | 24 HR(532/447) | | 36 HR(466/487) | | 48 HR(499/420) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -3.30 | -1.40 | -2.37 | -4.26 | -4.34 | -3.44 | -3.58 | -5.48 |
| T3 | -0.90 | -2.94 | -3.21 | -2.18 | -2.07 | -3.90 | -3.83 | -2.21 |
| T5 | -0.50 | -0.73 | -0.74 | -0.73 | -0.77 | -0.97 | -1.00 | -0.83 |
| SUM | -4.70 | -5.06 | -6.32 | -7.16 | -7.18 | -8.31 | -8.40 | -8.51 |

WINTER 1987 - 1988

PRECIPITATION FORECAST

| | 12 HR (73/71) | | 24 HR (85/86) | | 36 HR (82/82) | | 48 HR (93/94) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | +0.03 | +0.48 | +0.16 | -0.36 | -0.17 | +0.73 | +0.94 | -0.56 |
| T3 | -0.26 | -0.32 | -0.06 | -0.33 | -0.30 | +0.43 | +1.04 | -0.61 |
| T5 | +0.21 | -0.03 | +0.02 | +0.38 | +0.68 | +1.02 | +2.15 | +0.38 |
| SUM | -0.03 | +0.13 | +0.13 | -0.30 | +0.21 | +2.18 | +4.13 | -0.79 |

NO PRECIPITATION FORECAST

| | 12 HR(514/513) | | 24 HR(526/481) | | 36 HR(502/501) | | 48 HR(517/476) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -2.07 | -1.12 | -1.48 | -2.13 | -2.32 | -1.40 | -1.31 | -1.86 |
| T3 | -0.14 | -1.42 | -1.35 | -0.65 | -0.92 | -1.32 | -1.39 | -0.32 |
| T5 | +0.04 | -0.24 | +0.16 | -0.01 | +0.06 | +0.24 | +0.53 | +0.43 |
| SUM | -2.17 | -2.79 | -2.68 | -2.79 | -3.18 | -2.47 | -2.17 | -1.74 |

TABLE 6. Average algebraic temperature error for the winter season (October through March) for the winters 1985-86, 1986-87, 1987-88 stratified by forecast cycle time (0000Z or 1200Z) and NGM forecasts of precipitation or no precipitation. Numerals in parentheses are number of cases by cycle time (00Z/12Z) for specific time periods after initial data time.

WINTER 1985 - 1986

PRECIPITATION FORECAST

| | 12 HR(129/121) | | 24 HR(137/121) | | 36 HR(120/140) | | 48 HR(156/108) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | 2.61 | 2.80 | 3.15 | 3.09 | 3.25 | 4.01 | 4.04 | 3.79 |
| T3 | 1.40 | 2.04 | 2.16 | 1.93 | 2.36 | 2.55 | 2.87 | 3.03 |
| T5 | 1.17 | 0.84 | 1.44 | 1.50 | 1.99 | 2.16 | 2.94 | 2.37 |
| SUM | 5.19 | 5.68 | 6.75 | 6.51 | 7.60 | 8.72 | 9.85 | 9.19 |

NO PRECIPITATION FORECAST

| | 12 HR(361/347) | | 24 HR(365/314) | | 36 HR(338/317) | | 48 HR(351/312) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | 1.93 | 4.07 | 4.30 | 3.53 | 3.28 | 6.20 | 5.58 | 4.56 |
| T3 | 1.45 | 2.61 | 1.94 | 1.78 | 1.92 | 2.58 | 2.49 | 2.32 |
| T5 | 1.05 | 0.90 | 1.36 | 1.40 | 1.83 | 1.70 | 2.13 | 2.82 |
| SUM | 4.43 | 7.58 | 7.60 | 6.71 | 7.04 | 10.48 | 10.20 | 7.61 |

WINTER 1986 - 1987

PRECIPITATION FORECAST

| | 12 HR(108.98) | | 24 HR(121/145) | | 36 HR(158/128) | | 48 HR(133/160) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | 1.77 | 1.43 | 2.02 | 2.06 | 2.87 | 2.07 | 2.73 | 3.22 |
| T3 | 1.55 | 1.52 | 2.01 | 2.37 | 2.65 | 3.05 | 3.22 | 3.38 |
| T5 | 1.06 | 1.23 | 1.28 | 1.07 | 1.39 | 1.77 | 2.11 | 2.23 |
| SUM | 4.37 | 4.18 | 5.31 | 5.50 | 6.91 | 6.90 | 8.05 | 8.82 |

NO PRECIPITATION FORECAST

| | 12 HR(519/527) | | 24 HR(532/447) | | 36 HR(466/487) | | 48 HR(499/420) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | 3.37 | 1.72 | 2.51 | 4.26 | 4.45 | 3.53 | 3.65 | 5.53 |
| T3 | 1.52 | 3.07 | 3.37 | 2.57 | 2.56 | 3.99 | 4.05 | 2.84 |
| T5 | 1.01 | 1.10 | 1.25 | 1.24 | 1.44 | 1.49 | 1.87 | 1.84 |
| SUM | 5.91 | 5.90 | 7.13 | 8.07 | 8.46 | 9.01 | 9.58 | 10.20 |

WINTER 1987 - 1988

PRECIPITATION FORECAST

| | 12 HR (73/71) | | 24 HR (85/86) | | 36 HR (82/82) | | 48 HR (93/94) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | 1.32 | 1.49 | 1.74 | 1.97 | 2.49 | 2.06 | 2.63 | 2.29 |
| T3 | 1.27 | 1.42 | 1.66 | 1.63 | 2.01 | 2.43 | 2.78 | 2.46 |
| T5 | 0.97 | 1.04 | 1.08 | 1.29 | 1.56 | 1.88 | 2.86 | 2.21 |
| SUM | 3.56 | 3.96 | 4.48 | 4.88 | 6.06 | 6.37 | 8.28 | 6.95 |

NO PRECIPITATION FORECAST

| | 12 HR(514/513) | | 24 HR(526/481) | | 36 HR(502/501) | | 48 HR(517/476) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | 2.43 | 1.69 | 1.78 | 2.67 | 2.77 | 2.02 | 2.31 | 2.75 |
| T3 | 1.39 | 1.94 | 1.96 | 1.83 | 2.09 | 2.19 | 2.56 | 2.38 |
| T5 | 0.94 | 1.09 | 1.15 | 1.11 | 1.46 | 1.36 | 1.99 | 2.08 |
| SUM | 4.76 | 4.72 | 4.89 | 5.61 | 6.32 | 5.57 | 6.87 | 7.21 |

TABLE 7. Average absolute temperature error for the winter season (October through March) for the winters 1985-86, 1986-87, 1987-88 stratified by forecast cycle time (0000Z or 1200Z) and NGM forecasts of precipitation or no precipitation. Numerals in parentheses are number of cases by cycle time (00Z/12Z)for specific time periods after initial data time.

## WINTER 1985 - 1986

### PRECIPITATION FORECAST

| | 12 HR(121/129) | | 24 HR(137/121) | | 36 HR(140/120) | | 48 HR(156/108) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -0.69 | +0.79 | -0.73 | -0.50 | -1.51 | +0.03 | -0.67 | -0.38 |
| T3 | -0.72 | +0.03 | -0.31 | -0.87 | -0.18 | -0.61 | +0.62 | -0.38 |
| T5 | +0.10 | +0.60 | +1.04 | +1.07 | +1.56 | +1.44 | +2.13 | +1.67 |
| SUM | -1.31 | +1.42 | +0.01 | -0.30 | -0.14 | +0.87 | +2.08 | +0.91 |

### NO PRECIPITATION FORECAST

| | 12 HR(347/361) | | 24 HR(365/314) | | 36 HR(317/338) | | 48 HR(351/312) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -3.74 | -0.35 | -3.90 | -2.81 | -5.88 | -2.36 | -5.33 | -3.52 |
| T3 | -2.35 | -0.28 | -1.03 | -0.62 | -1.78 | +0.09 | -0.98 | +0.39 |
| T5 | +0.13 | +0.53 | +1.02 | +0.98 | +1.18 | +1.32 | +1.54 | +2.14 |
| SUM | -5.97 | -0.09 | -3.90 | -2.46 | -6.48 | -0.95 | -4.77 | -0.98 |

## WINTER 1986 - 1987

### PRECIPITATION FORECAST

| | 12 HR(98/108) | | 24 HR(121/145) | | 36 HR(128/158) | | 48 HR(133/160) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -0.06 | -0.66 | -0.83 | -1.32 | -1.66 | -2.37 | -1.48 | -2.18 |
| T3 | -1.17 | -0.79 | -1.64 | -2.01 | -2.10 | -2.25 | -2.41 | -1.88 |
| T5 | -0.21 | +0.06 | -0.12 | -0.42 | -0.15 | -0.43 | -0.35 | -0.16 |
| SUM | -1.45 | -1.39 | -2.60 | -3.75 | -3.91 | -5.06 | -4.23 | -4.21 |

### NO PRECIPITATION FORECAST

| | 12 HR(527/519) | | 24 HR(532/447) | | 36 HR(487/466) | | 48 HR(499/420) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -1.40 | -3.30 | -2.37 | -4.26 | -3.44 | -4.34 | -3.58 | -5.48 |
| T3 | -2.94 | -0.90 | -3.21 | -2.18 | -3.90 | -2.07 | -3.83 | -2.21 |
| T5 | -0.73 | -0.50 | -0.74 | -0.73 | -0.97 | -0.77 | -1.00 | -0.83 |
| SUM | -5.06 | -4.70 | -6.32 | -7.16 | -8.31 | -7.18 | -8.40 | -8.51 |

## WINTER 1987 - 1988

### PRECIPITATION FORECAST

| | 12 HR (71/73) | | 24 HR (85/86) | | 36 HR (82/82) | | 48 HR (93/94) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | +0.48 | +0.03 | +0.16 | -0.36 | +0.73 | -0.17 | +0.94 | -0.56 |
| T3 | -0.32 | -0.26 | -0.06 | -0.33 | +0.43 | -0.30 | +1.04 | -0.61 |
| T5 | -0.03 | +0.21 | +0.02 | +0.38 | +1.02 | +0.68 | +2.15 | +0.38 |
| SUM | +0.13 | -0.03 | +0.13 | -0.30 | +2.18 | +0.21 | +4.13 | -0.79 |

### NO PRECIPITATION FORECAST

| | 12 HR(513/514) | | 24 HR(526/481) | | 36 HR(501/502) | | 48 HR(517/476) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -1.12 | -2.07 | -1.48 | -2.13 | -1.40 | -2.32 | -1.31 | -1.86 |
| T3 | -1.42 | -0.14 | -1.35 | -0.65 | -1.32 | -0.92 | -1.39 | -0.32 |
| T5 | -0.24 | +0.04 | +0.16 | -0.01 | +0.24 | +0.06 | +0.53 | +0.43 |
| SUM | -2.79 | -2.17 | -2.68 | -2.79 | -2.47 | -3.18 | -2.17 | -1.74 |

TABLE 8. Average algebraic temperature error for the winter season (October through March) for the winters 1985-86, 1986-87, 1987-88 stratified by forecast valid time (0000Z or 1200Z) and NGM forecasts of precipitation or no precipitation. Numerals in parentheses are number of cases by valid time (00Z/12Z) for specific time periods after initial data time.

WINTER 1985 - 1986

PRECIPITATION FORECAST

| | 12 HR(121/129) 00Z | 12Z | 24 HR(137/121) 00Z | 12Z | 36 HR(140/120) 00Z | 12Z | 48 HR(156/108) 00Z | 12Z |
|---|---|---|---|---|---|---|---|---|
| T1 | 2.80 | 2.61 | 3.15 | 3.09 | 4.01 | 3.25 | 4.04 | 3.79 |
| T3 | 2.04 | 1.40 | 2.16 | 1.93 | 2.55 | 2.36 | 2.87 | 3.03 |
| T5 | 0.84 | 1.17 | 1.44 | 1.50 | 2.16 | 1.99 | 2.94 | 2.37 |
| SUM | 5.68 | 5.19 | 6.75 | 6.51 | 8.72 | 7.60 | 9.85 | 9.19 |

NO PRECIPITATION FORECAST

| | 12 HR(347/361) 00Z | 12Z | 24 HR(365/314) 00Z | 12Z | 36 HR(317/338) 00Z | 12Z | 48 HR(351/312) 00Z | 12Z |
|---|---|---|---|---|---|---|---|---|
| T1 | 4.07 | 1.93 | 4.30 | 3.53 | 6.20 | 3.28 | 5.58 | 4.56 |
| T3 | 2.61 | 1.45 | 1.94 | 1.78 | 2.58 | 1.92 | 2.49 | 2.32 |
| T5 | 0.90 | 1.05 | 1.36 | 1.40 | 1.70 | 1.83 | 2.13 | 2.82 |
| SUM | 7.58 | 4.43 | 7.60 | 6.71 | 10.48 | 7.04 | 10.20 | 7.61 |

WINTER 1986 - 1987

PRECIPITATION FORECAST

| | 12 HR(98/108) 00Z | 12Z | 24 HR(121/145) 00Z | 12Z | 36 HR(128/158) 00Z | 12Z | 48 HR(133/160) 00Z | 12Z |
|---|---|---|---|---|---|---|---|---|
| T1 | 1.43 | 1.77 | 2.02 | 2.06 | 2.07 | 2.87 | 2.73 | 3.22 |
| T3 | 1.52 | 1.55 | 2.01 | 2.37 | 3.05 | 2.65 | 3.22 | 3.38 |
| T5 | 1.23 | 1.06 | 1.28 | 1.07 | 1.77 | 1.39 | 2.11 | 2.23 |
| SUM | 4.18 | 4.37 | 5.31 | 5.50 | 6.90 | 6.91 | 8.05 | 8.82 |

NO PRECIPITATION FORECAST

| | 12 HR(527/519) 00Z | 12Z | 24 HR(532/447) 00Z | 12Z | 36 HR(487/466) 00Z | 12Z | 48 HR(499/420) 00Z | 12Z |
|---|---|---|---|---|---|---|---|---|
| T1 | 1.72 | 3.37 | 2.51 | 4.26 | 3.53 | 4.45 | 3.65 | 5.53 |
| T3 | 3.07 | 1.52 | 3.37 | 2.57 | 3.99 | 2.56 | 4.05 | 2.84 |
| T5 | 1.10 | 1.01 | 1.25 | 1.24 | 1.49 | 1.44 | 1.87 | 1.84 |
| SUM | 5.90 | 5.91 | 7.13 | 8.07 | 9.01 | 8.46 | 9.58 | 10.20 |

WINTER 1987 - 1988

PRECIPITATION FORECAST

| | 12 HR (71/73) 00Z | 12Z | 24 HR (85/86) 00Z | 12Z | 36 HR (82/82) 00Z | 12Z | 48 HR (93/94) 00Z | 12Z |
|---|---|---|---|---|---|---|---|---|
| T1 | 1.49 | 1.32 | 1.74 | 1.97 | 2.06 | 2.49 | 2.63 | 2.29 |
| T3 | 1.42 | 1.27 | 1.66 | 1.63 | 2.43 | 2.01 | 2.78 | 2.46 |
| T5 | 1.04 | 0.97 | 1.08 | 1.29 | 1.88 | 1.56 | 2.86 | 2.21 |
| SUM | 3.96 | 3.56 | 4.48 | 4.88 | 6.37 | 6.06 | 8.23 | 6.95 |

NO PRECIPITATION FORECAST

| | 12 HR(513/514) 00Z | 12Z | 24 HR(526/481) 00Z | 12Z | 36 HR(501/502) 00Z | 12Z | 48 HR(517/476) 00Z | 12Z |
|---|---|---|---|---|---|---|---|---|
| T1 | 1.69 | 2.43 | 1.78 | 2.67 | 2.02 | 2.77 | 2.31 | 2.75 |
| T3 | 1.94 | 1.39 | 1.96 | 1.83 | 2.19 | 2.09 | 2.56 | 2.38 |
| T5 | 1.09 | 0.94 | 1.15 | 1.11 | 1.36 | 1.46 | 1.99 | 2.08 |
| SUM | 4.72 | 4.76 | 4.89 | 5.61 | 5.57 | 6.32 | 6.87 | 7.21 |

TABLE 9. Average absolute temperature error for the winter season (October through March) for the winters 1985-86, 1986-87, 1987-88 stratified by forecast valid time (0000Z or 1200Z) and NGM forecasts of precipitation or no precipitation. Numerals in parentheses are number of cases by valid time (00Z/12Z) for specific time periods after initial data time.

WINTER 1985 - 1986

PRECIPITATION OBSERVED

| | 12 HR (190) | 24 HR (197) | 36 HR (199) | 48 HR (184) |
|---|---|---|---|---|
| T1 | +0.27 | -1.15 | -1.00 | -1.58 |
| T3 | -0.46 | -0.81 | -0.90 | -0.86 |
| T5 | +0.32 | +0.87 | +1.18 | +1.46 |
| SUM | +0.12 | -1.09 | -1.00 | -0.97 |

NO PRECIPITATION OBSERVED

| | 12 HR (768) | 24 HR (740) | 36 HR (716) | 48 HR (743) |
|---|---|---|---|---|
| T1 | -1.88 | -3.06 | -3.67 | -3.89 |
| T3 | -1.20 | -0.78 | -0.66 | -0.07 |
| T5 | +0.35 | +1.06 | +1.40 | +1.97 |
| SUM | -2.74 | -2.79 | -2.93 | -1.97 |

WINTER 1986 - 1987

PRECIPITATION OBSERVED

| | 12 HR (221) | 24 HR (221) | 36 HR (209) | 48 HR (203) |
|---|---|---|---|---|
| T1 | -0.78 | -1.60 | -2.50 | -2.88 |
| T3 | -1.00 | -2.04 | -2.71 | -2.83 |
| T5 | +0.14 | +0.01 | -0.11 | -0.15 |
| SUM | -1.64 | -3.62 | -5.33 | -5.86 |

NO PRECIPITATION OBSERVED

| | 12 HR (1031) | 24 HR (1024) | 36 HR (1030) | 48 HR (1009) |
|---|---|---|---|---|
| T1 | -2.28 | -3.03 | -3.65 | -4.01 |
| T3 | -1.94 | -2.66 | -2.84 | -2.86 |
| T5 | -0.67 | -0.78 | -0.87 | -0.88 |
| SUM | -4.89 | -6.47 | -7.36 | -7.75 |

WINTER 1987 - 1988

PRECIPITATION OBSERVED

| | 12 HR (221) | 24 HR (224) | 36 HR (219) | 48 HR (227) |
|---|---|---|---|---|
| T1 | -0.21 | -0.70 | -1.06 | -0.85 |
| T3 | -0.21 | -0.37 | -0.66 | -0.63 |
| T5 | +0.05 | +0.19 | +0.29 | +0.67 |
| SUM | -0.37 | -0.88 | -1.43 | -0.81 |

NO PRECIPITATION OBSERVED

| | 12 HR (950) | 24 HR (954) | 36 HR (948) | 48 HR (953) |
|---|---|---|---|---|
| T1 | -1.64 | -1.75 | -1.67 | -1.40 |
| T3 | -0.84 | -1.02 | -1.02 | -0.72 |
| T5 | -0.11 | +0.07 | +0.24 | +0.59 |
| SUM | -2.20 | -4.46 | -6.48 | -8.14 |

TABLE 10. Average algebraic temperature error for the winter season (October through March) for the winters 1985-86, 1986-87, 1987-88 stratified by observed precipitation or no precipitation events. Numerals in parentheses are number of cases for specific time periods after initial data time.

WINTER 1985 - 1986

PRECIPITATION OBSERVED

| | 12 HR (190) | 24 HR (197) | 36 HR (199) | 48 HR (184) |
|---|---|---|---|---|
| T1 | 2.91 | 3.49 | 3.95 | 4.18 |
| T3 | 1.80 | 2.41 | 2.93 | 2.97 |
| T5 | 1.07 | 1.47 | 1.96 | 2.45 |
| SUM | 5.77 | 7.37 | 8.84 | 9.60 |

NO PRECIPITATION OBSERVED

| | 12 HR (768) | 24 HR (740) | 36 HR (716) | 48 HR (743) |
|---|---|---|---|---|
| T1 | 2.90 | 3.78 | 4.53 | 4.92 |
| T3 | 1.97 | 1.78 | 2.13 | 2.45 |
| T5 | 0.97 | 1.38 | 1.83 | 2.55 |
| SUM | 5.84 | 6.95 | 8.48 | 9.91 |

WINTER 1986 - 1987

PRECIPITATION OBSERVED

| | 12 HR (221) | 24 HR (221) | 36 HR (209) | 48 HR (203) |
|---|---|---|---|---|
| T1 | 1.80 | 2.26 | 3.04 | 3.61 |
| T3 | 1.62 | 2.52 | 3.18 | 3.61 |
| T5 | 1.14 | 1.32 | 1.51 | 2.19 |
| SUM | 4.56 | 6.10 | 7.73 | 9.40 |

NO PRECIPITATION OBSERVED

| | 12 HR (1031) | 24 HR (1024) | 36 HR (1030) | 48 HR (1009) |
|---|---|---|---|---|
| T1 | 2.51 | 3.20 | 3.77 | 4.25 |
| T3 | 2.30 | 2.85 | 3.19 | 3.42 |
| T5 | 1.06 | 1.21 | 1.48 | 1.88 |
| SUM | 5.87 | 7.27 | 8.44 | 9.55 |

WINTER 1987 - 1988

PRECIPITATION OBSERVED

| | 12 HR (221) | 24 HR (224) | 36 HR (219) | 48 HR (227) |
|---|---|---|---|---|
| T1 | 1.54 | 1.95 | 2.57 | 2.55 |
| T3 | 1.33 | 1.58 | 2.26 | 2.70 |
| T5 | 1.05 | 1.20 | 1.63 | 2.29 |
| SUM | 3.92 | 4.72 | 6.46 | 7.55 |

NO PRECIPITATION OBSERVED

| | 12 HR (950) | 24 HR (954) | 36 HR (948) | 48 HR (953) |
|---|---|---|---|---|
| T1 | 2.08 | 2.20 | 2.34 | 2.50 |
| T3 | 1.69 | 1.93 | 2.12 | 2.45 |
| T5 | 1.01 | 1.13 | 1.41 | 2.07 |
| SUM | 4.78 | 5.25 | 5.87 | 7.03 |

TABLE 11. Average absolute temperature error for the winter season (October through March) for the winters 1985-86, 1986-87, 1987-88 stratified by observed precipitation or no precipitation events. Numerals in parentheses are number of cases for specific time periods after initial data time.

WINTER 1985 - 1986

PRECIPITATION OBSERVED

| | 12 HR (105/85) | | 24 HR (106/91) | | 36 HR (101/98) | | 48 HR (97/87) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | +0.63 | -0.33 | -1.14 | -0.84 | -0.11 | -2.33 | -2.09 | -0.41 |
| T3 | +0.08 | -1.01 | -0.55 | -0.91 | -0.49 | -1.18 | -0.93 | -0.26 |
| T5 | +0.95 | +0.08 | +0.94 | +0.74 | +1.27 | +0.84 | +1.20 | +1.60 |
| SUM | +1.23 | -1.26 | -0.75 | -1.01 | +0.67 | -2.67 | -1.82 | +0.92 |

NO PRECIPITATION OBSERVED

| | 12 HR(385/383) | | 24 HR(396/344) | | 36 HR(357/359) | | 48 HR(410/333) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | +0.05 | -3.53 | -3.54 | -2.52 | -2.19 | -5.14 | -4.32 | -3.31 |
| T3 | -0.27 | -2.14 | -0.91 | -0.63 | +0.01 | -1.32 | -0.39 | +0.31 |
| T5 | +0.56 | +0.13 | +1.05 | +1.07 | +1.38 | +1.42 | +1.85 | +2.13 |
| SUM | +0.05 | -5.54 | -3.40 | -2.08 | -0.80 | -5.04 | -2.86 | -0.87 |

WINTER 1986 - 1987

PRECIPITATION OBSERVED

| | 12 HR(118/103) | | 24 HR(107/114) | | 36 HR(111/98) | | 48 HR(103/100) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -1.05 | -0.48 | -1.52 | -1.68 | -2.42 | -2.60 | -2.81 | -2.95 |
| T3 | -0.79 | -1.24 | -1.90 | -2.17 | -2.62 | -2.81 | -3.01 | -2.65 |
| T5 | +0.13 | +0.17 | +0.54 | -0.48 | -0.45 | +0.28 | +0.22 | -0.53 |
| SUM | -1.71 | -1.55 | -2.88 | -4.32 | -5.50 | -5.13 | -5.59 | -5.81 |

NO PRECIPITATION OBSERVED

| | 12 HR(509/522) | | 24 HR(546/478) | | 36 HR(513/517) | | 48 HR(529/480) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -3.26 | -1.33 | -2.19 | -3.98 | -4.15 | -3.15 | -3.20 | -4.90 |
| T3 | -0.90 | -2.94 | -3.12 | -2.13 | -2.01 | -3.66 | -3.63 | -2.00 |
| T5 | -0.53 | -0.81 | -0.86 | -0.70 | -0.74 | -1.01 | -1.08 | -0.67 |
| SUM | -4.69 | -5.08 | -6.17 | -6.81 | -6.89 | -7.82 | -7.90 | -7.58 |

WINTER 1987 - 1988

PRECIPITATION OBSERVED

| | 12 HR(122/99) | | 24 HR(111/113) | | 36 HR(128/91) | | 48 HR(107/120) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -0.68 | +0.37 | -0.60 | -0.79 | -1.53 | -0.41 | -0.34 | -1.31 |
| T3 | -0.16 | -0.26 | -0.39 | -0.35 | -0.95 | -0.24 | -0.32 | -0.91 |
| T5 | +0.02 | +0.09 | +0.15 | +0.23 | +0.11 | +0.54 | +0.86 | +0.49 |
| SUM | -0.83 | +0.20 | -0.84 | -0.91 | -2.38 | -0.11 | +0.21 | -1.73 |

NO PRECIPITATION OBSERVED

| | 12 HR(465/485) | | 24 HR(500/454) | | 36 HR(456/492) | | 48 HR(450/503) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -2.10 | -1.19 | -1.40 | -2.13 | -2.15 | -1.22 | -1.10 | -1.74 |
| T3 | -0.15 | -1.50 | -1.35 | -0.66 | -0.80 | -1.23 | -1.17 | -0.22 |
| T5 | +0.07 | -0.28 | +0.13 | +0.00 | +0.15 | +0.32 | +0.76 | +0.41 |
| SUM | -2.18 | -2.97 | -2.61 | -2.79 | -2.80 | -2.13 | -1.51 | -1.55 |

TABLE 12. Average algebraic temperature error for the winter season (October through March) for the winters 1985-86, 1986-87, 1987-88 stratified by forecast cycle time (0000Z or 1200Z) and by observed precipitation or no precipitation events. Numerals in parentheses are number of cases by cycle time (00Z/12Z)for specific time periods after initial data time.

WINTER 1985 - 1986

PRECIPITATION OBSERVED

| | 12 HR (105/85) 00Z | 12Z | 24 HR (106/91) 00Z | 12Z | 36 HR (101/98) 00Z | 12Z | 48 HR (97/87) 00Z | 12Z |
|---|---|---|---|---|---|---|---|---|
| T1 | 2.83 | 3.00 | 3.38 | 3.63 | 3.36 | 4.56 | 4.51 | 3.82 |
| T3 | 1.53 | 2.13 | 2.55 | 2.25 | 2.55 | 3.32 | 3.26 | 2.66 |
| T5 | 1.32 | 0.75 | 1.45 | 1.48 | 1.94 | 1.98 | 2.47 | 2.43 |
| SUM | 5.69 | 5.88 | 7.37 | 7.36 | 7.79 | 9.86 | 10.24 | 8.90 |

NO PRECIPITATION OBSERVED

| | 12 HR(385/383) 00Z | 12Z | 24 HR(396/344) 00Z | 12Z | 36 HR(357/359) 00Z | 12Z | 48 HR(410/333) 00Z | 12Z |
|---|---|---|---|---|---|---|---|---|
| T1 | 1.91 | 3.90 | 4.15 | 3.35 | 3.25 | 5.80 | 5.25 | 4.50 |
| T3 | 1.41 | 2.53 | 1.85 | 1.70 | 1.89 | 2.36 | 2.45 | 2.46 |
| T5 | 1.02 | 0.92 | 1.36 | 1.41 | 1.85 | 1.80 | 2.35 | 2.78 |
| SUM | 4.34 | 7.36 | 7.37 | 6.47 | 6.99 | 9.96 | 10.05 | 9.74 |

WINTER 1986 - 1987

PRECIPITATION OBSERVED

| | 12 HR(118/103) 00Z | 12Z | 24 HR(107/114) 00Z | 12Z | 36 HR(111/98) 00Z | 12Z | 48 HR(103/100) 00Z | 12Z |
|---|---|---|---|---|---|---|---|---|
| T1 | 2.14 | 1.41 | 2.14 | 2.38 | 3.05 | 3.03 | 3.33 | 3.89 |
| T3 | 1.52 | 1.75 | 2.50 | 2.54 | 2.89 | 3.50 | 3.53 | 3.69 |
| T5 | 1.13 | 1.16 | 1.53 | 1.11 | 1.50 | 1.52 | 1.70 | 2.69 |
| SUM | 4.78 | 4.31 | 6.17 | 6.03 | 7.44 | 8.05 | 8.56 | 10.27 |

NO PRECIPITATION OBSERVED

| | 12 HR(509/522) 00Z | 12Z | 24 HR(546/478) 00Z | 12Z | 36 HR(513/517) 00Z | 12Z | 48 HR(529/480) 00Z | 12Z |
|---|---|---|---|---|---|---|---|---|
| T1 | 3.32 | 1.72 | 2.47 | 4.04 | 4.27 | 3.27 | 3.48 | 5.10 |
| T3 | 1.53 | 3.04 | 3.24 | 2.41 | 2.51 | 3.85 | 3.95 | 2.84 |
| T5 | 1.00 | 1.12 | 1.20 | 1.22 | 1.42 | 1.55 | 1.97 | 1.79 |
| SUM | 5.84 | 5.89 | 6.92 | 7.66 | 8.20 | 8.67 | 9.39 | 9.73 |

WINTER 1987 - 1988

PRECIPITATION OBSERVED

| | 12 HR(122/99) 00Z | 12Z | 24 HR(111/113) 00Z | 12Z | 36 HR(128/91) 00Z | 12Z | 48 HR(107/120) 00Z | 12Z |
|---|---|---|---|---|---|---|---|---|
| T1 | 1.65 | 1.40 | 1.59 | 2.30 | 2.89 | 2.11 | 2.17 | 2.89 |
| T3 | 1.37 | 1.29 | 1.37 | 1.79 | 2.44 | 2.02 | 2.67 | 2.73 |
| T5 | 1.03 | 1.08 | 0.97 | 1.42 | 1.64 | 1.62 | 2.34 | 2.25 |
| SUM | 4.04 | 3.78 | 3.93 | 5.50 | 6.97 | 5.75 | 7.18 | 7.88 |

NO PRECIPITATION OBSERVED

| | 12 HR(465/485) 00Z | 12Z | 24 HR(500/454) 00Z | 12Z | 36 HR(456/492) 00Z | 12Z | 48 HR(450/503) 00Z | 12Z |
|---|---|---|---|---|---|---|---|---|
| T1 | 2.46 | 1.72 | 1.81 | 2.62 | 2.68 | 2.01 | 2.40 | 2.62 |
| T3 | 1.38 | 2.00 | 2.04 | 1.80 | 1.98 | 2.26 | 2.58 | 2.30 |
| T5 | 0.92 | 1.09 | 1.18 | 1.07 | 1.43 | 1.40 | 2.08 | 2.06 |
| SUM | 4.76 | 4.80 | 5.04 | 5.50 | 6.09 | 5.67 | 7.06 | 6.98 |

TABLE 13. Average absolute temperature error for the winter season (October through March) for the winters 1985-86, 1986-87, 1987-88 stratified by forecast cycle time (0000Z or 1200Z) and by observed precipitation or no precipitation events. Numerals in parentheses are number of cases by cycle time (00Z/12Z) for specific time periods after initial data time.

WINTER 1985 - 1986

PRECIPITATION OBSERVED

| | 12 HR (85/105) | | 24 HR (106/91) | | 36 HR (98/101) | | 48 HR (97/87) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -0.33 | +0.63 | -1.14 | -0.84 | -2.33 | -0.11 | -2.09 | -0.41 |
| T3 | -1.01 | +0.08 | -0.55 | -0.91 | -1.18 | -0.49 | -0.93 | -0.26 |
| T5 | +0.08 | +0.95 | +0.94 | +0.74 | +0.84 | +1.27 | +1.20 | +1.60 |
| SUM | -1.26 | +1.23 | -0.75 | -1.01 | -2.67 | +0.67 | -1.82 | +0.92 |

NO PRECIPITATION OBSERVED

| | 12 HR(383/385) | | 24 HR(396/344) | | 36 HR(359/357) | | 48 HR(410/333) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -3.53 | +0.05 | -3.54 | -2.52 | -5.14 | -2.19 | -4.32 | -3.31 |
| T3 | -2.14 | -0.27 | -0.91 | -0.63 | -1.32 | +0.01 | -0.39 | +0.31 |
| T5 | +0.13 | +0.56 | +1.05 | +1.07 | +1.42 | +1.38 | +1.85 | +2.13 |
| SUM | -5.54 | +0.05 | -3.40 | -2.08 | -5.04 | -0.80 | -2.86 | -0.87 |

WINTER 1986 - 1987

PRECIPITATION OBSERVED

| | 12 HR(103/118) | | 24 HR(107/114) | | 36 HR(98/111) | | 48 HR(103/100) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -0.48 | -1.05 | -1.52 | -1.68 | -2.60 | -2.42 | -2.81 | -2.95 |
| T3 | -1.24 | -0.79 | -1.90 | -2.17 | -2.81 | -2.62 | -3.01 | -2.65 |
| T5 | +0.17 | +0.13 | +0.54 | -0.48 | +0.28 | -0.45 | +0.22 | -0.53 |
| SUM | -1.55 | -1.71 | -2.88 | -4.32 | -5.13 | -5.50 | -5.59 | -5.81 |

NO PRECIPITATION OBSERVED

| | 12 HR(522/509) | | 24 HR(546/478) | | 36 HR(517/513) | | 48 HR(529/480) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -1.33 | -3.26 | -2.19 | -3.98 | -3.15 | -4.15 | -3.20 | -4.90 |
| T3 | -2.94 | -0.90 | -3.12 | -2.13 | -3.66 | -2.01 | -3.63 | -2.00 |
| T5 | -0.81 | -0.53 | -0.86 | -0.70 | -1.01 | -0.74 | -1.08 | -0.67 |
| SUM | -5.08 | -4.69 | -6.17 | -6.81 | -7.82 | -6.89 | -7.90 | -7.58 |

WINTER 1987 - 1988

PRECIPITATION OBSERVED

| | 12 HR(99/122) | | 24 HR(111/113) | | 36 HR(91/128) | | 48 HR(107/120) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | +0.37 | -0.68 | -0.60 | -0.79 | -0.41 | -1.53 | -0.34 | -1.31 |
| T3 | -0.26 | -0.16 | -0.39 | -0.35 | -0.24 | -0.95 | -0.32 | -0.91 |
| T5 | +0.09 | +0.02 | +0.15 | +0.23 | +0.54 | +0.11 | +0.86 | +0.49 |
| SUM | +0.20 | -0.83 | -0.84 | -0.91 | -0.11 | -2.38 | +0.21 | -1.73 |

NO PRECIPITATION OBSERVED

| | 12 HR(485/465) | | 24 HR(500/454) | | 36 HR(492/456) | | 48 HR(450/503) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | -1.19 | -2.10 | -1.40 | -2.13 | -1.22 | -2.15 | -1.10 | -1.74 |
| T3 | -1.50 | -0.15 | -1.35 | -0.66 | -1.23 | -0.80 | -1.17 | -0.22 |
| T5 | -0.28 | +0.07 | +0.13 | +0.00 | +0.32 | +0.15 | +0.76 | +0.41 |
| SUM | -2.97 | -2.18 | -2.61 | -2.79 | -2.13 | -2.80 | -1.51 | -1.55 |

TABLE 14. Average algebraic temperature error for the winter season (October through March) for the winters 1985-86, 1986-87, 1987-88 stratified by forecast valid time (0000Z or 1200Z) and by observed precipitation or no precipitation events. Numerals in parentheses are number of cases by valid time (00Z/12Z) for specific time periods after initial data time.

## WINTER 1985 - 1986

PRECIPITATION OBSERVED

| | 12 HR (85/105) | | 24 HR (106/91) | | 36 HR (98/101) | | 48 HR (97/87) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | 3.00 | 2.83 | 3.38 | 3.63 | 4.56 | 3.36 | 4.51 | 3.82 |
| T3 | 2.13 | 1.53 | 2.55 | 2.25 | 3.32 | 2.55 | 3.26 | 2.66 |
| T5 | 0.75 | 1.32 | 1.45 | 1.48 | 1.98 | 1.94 | 2.47 | 2.43 |
| SUM | 5.88 | 5.69 | 7.37 | 7.36 | 9.86 | 7.79 | 10.24 | 8.90 |

NO PRECIPITATION OBSERVED

| | 12 HR(383/385) | | 24 HR(396/344) | | 36 HR(359/357) | | 48 HR(410/333) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | 3.90 | 1.91 | 4.15 | 3.35 | 5.80 | 3.25 | 5.25 | 4.50 |
| T3 | 2.53 | 1.41 | 1.85 | 1.70 | 2.36 | 1.89 | 2.45 | 2.46 |
| T5 | 0.92 | 1.02 | 1.36 | 1.41 | 1.80 | 1.85 | 2.35 | 2.78 |
| SUM | 7.36 | 4.34 | 7.37 | 6.47 | 9.96 | 6.69 | 10.05 | 9.74 |

## WINTER 1986 - 1987

PRECIPITATION OBSERVED

| | 12 HR(103/118) | | 24 HR(107/114) | | 36 HR(98/111) | | 48 HR(103/100) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | 1.41 | 2.14 | 2.14 | 2.38 | 3.03 | 3.05 | 3.33 | 3.89 |
| T3 | 1.75 | 1.52 | 2.50 | 2.54 | 3.50 | 2.89 | 3.53 | 3.69 |
| T5 | 1.16 | 1.13 | 1.53 | 1.11 | 1.52 | 1.50 | 1.70 | 2.69 |
| SUM | 4.31 | 4.78 | 6.17 | 6.03 | 8.05 | 7.44 | 8.56 | 10.27 |

NO PRECIPITATION OBSERVED

| | 12 HR(522/509) | | 24 HR(546/478) | | 36 HR(517/513) | | 48 HR(529/480) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | 1.72 | 3.32 | 2.47 | 4.04 | 3.27 | 4.27 | 3.48 | 5.10 |
| T3 | 3.04 | 1.53 | 3.24 | 2.41 | 3.85 | 2.51 | 3.95 | 2.84 |
| T5 | 1.12 | 1.00 | 1.20 | 1.22 | 1.55 | 1.42 | 1.97 | 1.79 |
| SUM | 5.89 | 5.84 | 6.92 | 7.66 | 8.67 | 8.20 | 9.39 | 9.73 |

## WINTER 1987 - 1988

PRECIPITATION OBSERVED

| | 12 HR(99/122) | | 24 HR(111/113) | | 36 HR(91/128) | | 48 HR(107/120) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | 1.40 | 1.65 | 1.59 | 2.30 | 2.11 | 2.89 | 2.17 | 2.89 |
| T3 | 1.29 | 1.37 | 1.37 | 1.79 | 2.02 | 2.44 | 2.67 | 2.73 |
| T5 | 1.08 | 1.03 | 0.97 | 1.42 | 1.62 | 1.64 | 2.34 | 2.25 |
| SUM | 3.78 | 4.04 | 3.93 | 5.50 | 5.75 | 6.97 | 7.18 | 7.88 |

NO PRECIPITATION OBSERVED

| | 12 HR(485/465) | | 24 HR(500/454) | | 36 HR(492/456) | | 48 HR(450/503) | |
|---|---|---|---|---|---|---|---|---|
| | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z | 00Z | 12Z |
| T1 | 1.72 | 2.46 | 1.81 | 2.62 | 2.01 | 2.68 | 2.40 | 2.62 |
| T3 | 2.00 | 1.38 | 2.04 | 1.80 | 2.26 | 1.98 | 2.58 | 2.30 |
| T5 | 1.09 | 0.92 | 1.18 | 1.07 | 1.40 | 1.43 | 2.08 | 2.06 |
| SUM | 4.80 | 4.76 | 5.04 | 5.50 | 5.67 | 6.09 | 7.06 | 6.98 |

TABLE 15. Average absolute temperature error for the winter season (October through March) for the winters 1985-86, 1986-87, 1987-88 stratified by forecast valid time (0000Z or 1200Z) and by observed precipitation or no precipitation events. Numerals in parentheses are number of cases by valid time (00Z/12Z) for specific time periods after initial data time.